

# A theory of alpha/theta neurofeedback, creative performance enhancement, long distance functional connectivity and psychological integration

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**Abstract** Professionally significant enhancement of music and dance performance and mood has followed training with an EEG-neurofeedback protocol which increases the ratio of theta to alpha waves using auditory feedback with eyes closed. While originally the protocol was designed to induce hypnagogia, a state historically associated with creativity, the outcome was psychological integration, while subsequent applications focusing on raising the theta–alpha ratio, reduced depression and anxiety in alcoholism and resolved post traumatic stress syndrome (PTSD). In optimal performance studies we confirmed associations with creativity in musical performance, but effects also included technique and communication. We extended efficacy to dance and social anxiety. Diversity of outcome has a counterpart in wide ranging associations between theta oscillations and behaviour in cognitive and affective neuroscience: in animals with sensory-motor activity in exploration, effort, working memory, learning, retention and REM sleep; in man with meditative concentration, reduced anxiety and sympathetic autonomic activation, as well as task demands in virtual spatial navigation, focussed and sustained attention, working and recognition memory, and having implications for synaptic plasticity and long term potentiation. Neuroanatomical circuitry involves the ascending mesencephalic-cortical arousal system, and limbic circuits subserving cognitive as well as affective/motivational functions. Working memory and meditative bliss, representing cognitive and affective domains,

respectively, involve coupling between frontal and posterior cortices, exemplify a role for theta and alpha waves in mediating the interaction between distal and widely distributed connections. It is posited that this mediation in part underpins the integrational attributes of alpha–theta training in optimal performance and psychotherapy, creative associations in hypnagogia, and enhancement of technical, communication and artistic domains of performance in the arts.

**Keywords** Theta waves · Neurofeedback · Performance enhancement · Cognition · Mood · Connectivity

## Alpha/theta wave neurofeedback training protocol

The alpha/theta (A/T) training protocol involves recording the occurrence of alpha and theta activity in the electroencephalogram (EEG) while the participant relaxes with eyes closed. This is done by presenting pleasing sounds, such as waves gently crashing on the beach or a babbling brook, contingent on the production of theta and alpha, respectively. The relative reward contingencies for alpha and theta are gradually changed with the aim of maximising the theta to alpha ratio (see Egner et al. 2002 for the temporal dynamics of the training protocol). The production of theta with eyes closed is a well known accompaniment of states of deep relaxation such as stage 1 sleep, meditation and hypnosis (Vaitl et al. 2005). However, the production of theta activity which accompanies a positive affective state is not to be confused with theta that occurs with eyes open, which may coincide with fatigue and inattention as in attention deficit disorder (ADD).

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